

Report for 2004MI42B: Natural Resources Integrated Information System

- Conference Proceedings:
 - Allen, L.H. Jr., K.F. Heimborg, R.G. Bill Jr., J.F. Bartholic, and K.J. Boote. 2004. Remotely Sensed Temperatures and Evapotranspiration of Heterogeneous Grass and Citrus Tree-Canopy Surfaces. Soil Crop Science Society Florida Proceedings, Volume 63, pp. 1-20.
 - Kettren, L.P., S. Miller, P.K.B. Hunt, A. Simard, J. Bartholic. 2004. Investigating the Groundwater Quantity Effects on Ecosystems and Human Activities for Informed Groundwater Policy. Proceedings from UCOWR Conference, Portland, OR. 11 pp.
 - Kettren, L.P., S. Miller, P.K.B. Hunt, A. Simard, J. Bartholic. 2004. Investigating the Groundwater Quantity Effects on Ecosystems and Human Activities for Informed Groundwater Policy. Proceedings from UCOWR Conference, Portland, OR. 11 pp.
- Other Publications:
 - Bartholic, Jon. 2003. Midwest Groundwater Conference Lecture
 - Bartholic, Jon. 2003. 45th Annual Regulatory Studies Program (Presentation).
 - Bartholic, Jon. 2003. Digital Watershed: A Nationwide Web Application Tool for Effective Watershed Management presentation in Muskegon, Michigan at the Michigan State of the Lakes Conference, October 2003.
 - Bartholic, J., 2003. Presented Water Supply and Resource Management at the 45th Annual NARUC Regulatory Studies Program sponsored by the Institute of Public Utilities of Michigan State University. August 10, East Lansing, MI.
 - Bartholic, J. 2003. Presented Pesticides: Its not just about bugs at the Agriculture Conference on the Environment. March 24, Lansing, MI.
 - Bartholic, J. 2003. Presented About Digital Watershed at the Lake Michigan State of the Lake 03 Conference. October 21-22, Muskegon, MI
 - Bartholic, J. 2003. Presented Models of Weather Patterns: Where Does Irrigation Water Go? Consumptive Use at the Michigan Irrigation Association Irrigation Workshop. December 4, Shipshewana, IN.
 - Bartholic, J. 2004. Presented at Michigan Land Use Summit sponsored by the Land Policy Program of Michigan State University. February 2-3, East Lansing, MI
 - Bartholic, J. 2004. Presented MSU 2003 Research Results on Drip Irrigation at the Southwest Michigan Irrigation Workshop. January 27-28, Benton Harbor, MI.
- Articles in Refereed Scientific Journals:
 - Ouyang, D., J. Bartholic, and J. Selegan. 2003. Assessing Soil Erosion and Sediment Load from Agricultural Croplands in the Great Lakes Basin, The Journal of Great Lakes Research. (In review).
 - Shi, Y., J. Asher, J. Bartholic, et al. 2004. An Online WebGIS-based Hierarchical Watershed Decision Support System for United States. Journal of Environmental Informatics. 7pp. In Review.

Report Follows

Institute of Water Research

Annual Technical Report

FY 2004

Introduction

The Institute of Water Research (IWR) at Michigan State University (MSU) continuously provides timely information for addressing contemporary land and water resource issues through coordinated multidisciplinary efforts using advanced information and networking systems. The IWR endeavors to strengthen MSU's efforts in nontraditional education, outreach, and interdisciplinary studies utilizing available advanced technology, and partnerships with local, state, regional, and federal organizations and individuals. Activities include coordinating education and training programs on surface and ground water protection, land use and watershed management, and many others. (An extended introduction can be found in our FY2001 Annual Technical Report.) We also encourage accessing our web site which offers a more comprehensive resource on IWR activities, goals, and accomplishments: www.iwr.msu.edu.

The Institute has increasingly recognized the acute need and effort for multi-disciplinary research to achieve better water management and improved water quality. This effort involves the integration of research data and knowledge with the application of models and geographic information systems (GIS) to produce spatial decision support systems (SDSS). These geospatial decision support systems provide an analytical framework and research data via the web to assist individuals and local and state government agencies make wise resource decisions. The Institute has also increasingly become a catalyst for region wide decision-making support in partnership with other states in EPA Region 5 using state-of-the-art decision support systems.

The Institute also works closely with the MSU Cooperative Extension Service to conduct outreach and education. USGS support of this Institute as well as others in the region enhances the Institute credibility and facilitates partnerships with other federal agencies, universities, and local and state government agencies. The Institute also provides important support to MSU-WATER, a major university initiative dealing with urban stormwater issues with funding from the university Vice President for Finance. A member of the Institute's staff works half-time in facilitating MSU-WATER activities so the Institute enjoys a close linkage with this project. The following provides a more detailed explanation of the Institute's general philosophy and approach in defining its program areas and responsibilities.

General Statement

To deal successfully with the emergence of water resource issues unique to the 21st century, transformation of our knowledge and understanding of water for the protection, conservation, and management of water resources is imperative. Radically innovative approaches involving our best scientific knowledge, extensive spatial databases, and "intelligent" tools that visualize wise resource management and conservation in a single holistic system are likewise imperative. Finally, holistic system analysis and understanding requires a strong and integrated multi-disciplinary framework

Research Program

The management of water resources, appropriate policies, and data acquisition and modeling continue to be at the forefront of the State Legislatures agenda and numerous environmental and agricultural organizations. Our contribution to informing the debate involved numerous meetings, personal discussions, and most importantly, the enhancement of web-based information to aid in the informed decision-making process.

Unique Capabilities: Decision Support Systems As The Nexus

IWR, with its “extended research family,” is exceptionally well-positioned to integrate research conducted within each of the three principal water research domains: hydrologic sciences, water resources, and aquatic ecosystems. Integrated decision support both reflects and forms the nexus of these three research domains. Expanding web accessibility to the decision support system nexus (formed by the intersection of the three research domains) will facilitate broad distribution of science-based research produced in these domains.

The Institute’s extensive experience in regional and national networking provides exceptional opportunities for assembling multi-agency funding to support interdisciplinary water research projects and multi-university partnerships.

Using A Multi-Disciplinary Framework

Using a multi-disciplinary framework facilitates dynamic applications of information to create geospatial, place-based strategies, including watershed management tools, to optimize economic benefits and assure long-term sustainability of valuable water resources. New information technologies including GIS and computational analysis, enhanced human/machine interfaces that drive better information distribution, and access to extensive real-time environmental datasets make a new “intelligent reality” possible.

Effective watershed management requires integration of theory, data, simulation models, and expert judgment to solve practical problems. Geospatial decision support systems meet these requirements with the capacity to assess and present information geographically, or spatially, through an interface with a geographic information system (GIS). Through the integration of databases, simulation models, and user interfaces, these systems are designed to assist decisionmakers in evaluating the economic and environmental impacts of various watershed management alternatives.

The ultimate goal of these new imperatives is to secure and protect the future of water quality and supplies in the Great Lakes Basin and across the country and the world—with management strategies based on an understanding of the uniqueness of each watershed.

Natural Resources Integrated Information System

Basic Information

Title: Natural Resources Integrated Information System

Project Number: 2004MI42B

Start Date: 3/1/2004

End Date: 2/28/2005

Funding Source: 104B

Congressional District: Eighth

Research Category: None

Focus Category: Management and Planning, Water Quality, Models

Descriptors: None

Principal Investigators: Jon Bartholic

Publication

1. Bartholic, Jon. 2003. Midwest Groundwater Conference Lecture.
2. Bartholic, Jon. 2003. 45th Annual Regulatory Studies Program (Presentation).
3. Bartholic, Jon. 2003. Digital Watershed: A Nationwide Web Application Tool for Effective Watershed Management presentation in Muskegon, Michigan at the Michigan State of the Lakes Conference, October 2003.

Publications Resulting from Projects Prior to FY 2003

4. Nelson, S.A.C., P.A. Soranno, K.S. Cheruvilil, S.A. Batzli and D.L. Skole. 2003. Regional assessment of lake water clarity using satellite remote sensing, *Journal of Limnology*.
5. Cheruvilil, K.S., N.A. Nate, P.A. Soranno, M.T. Bremigan 2003. A field-test of the unimodal relationship between fish growth and macrophyte cover in lakes, Submitted to *Ecological Applications*.
6. Nelson, S.A.C., K.S. Cheruvilil, and P.A. Soranno. 2003. Remote sensing of freshwater macrophytes and the influence of lake characteristics. Submitted to *Aquatic Botany*

Pertinent Publications and Presentations

Ouyang, D., J. Bartholic, and J. Selegan. 2003. Assessing Soil Erosion and Sediment Load from Agricultural Croplands in the Great Lakes Basin, *The Journal of Great Lakes Research*. (In review).

Bartholic, J., 2003. Presented "Water Supply and Resource Management" at the 45th Annual NARUC Regulatory Studies Program sponsored by the Institute of Public Utilities of Michigan State University. August 10, East Lansing, MI.

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Michigan Institute of Water Research Water Research
Institute Program Report for FY 2004
Submitted by Dr. Jon Bartholic, Director

Introduction

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Project Number: 2004MI42B

Start: 03/01/04 (actual)

End: 02/28/05 (expected)

Title: Natural Resources Integrated Information System

Investigators: Jon F. Bartholic, Institute of Water Research, Michigan State University

Focus Categories: M & P, WQL, MOD

Congressional District: eighth

Descriptors: Data Analysis, Data Storage and Retrieval, Information Dissemination, System Analysis, Geographic Information Systems, Water Quality Management, Watershed Management

Areas of Relevant Research

The management of water resources, appropriate policies, and data acquisition and modeling continue to be at the forefront of the State Legislature's agenda and numerous environmental and agricultural organizations. Our contribution to informing the debate involved numerous meetings, personal discussions, and most importantly, the enhancement of web-based information to aid in the informed decision-making process.

Results and Benefits

Extensive investigation and research is needed to achieve effective coupling of human management needs with geospatial databases and decision support systems to assist better decision-making. Multiple research funding opportunities exist to support linking understanding of various phases of the hydrologic cycle with impacts on water use, management, and conservation. As a result, outstanding opportunities to develop scientific water management skills and techniques for the 21st Century are clearly within reach.

Development of geospatial decision support systems complement and build on the extensive scientific knowledge of the role of the hydrologic balance in the functioning of dynamic ecosystems. Based on current development of geospatial databases and modeling systems, a model of the hydrologic balance for the state can be developed to assist water management and conservation. By incorporating extensive geospatial data with the analytical capacity of decision support systems, university researchers are providing decision-makers and managers with a more refined understanding of the hydrologic cycle and water balance functions at watershed and statewide scales.

Our USGS investments over the past two years led to a two-year \$540,000 grant from the Great Lakes Protection Fund awarded to Michigan State University and the Institute of Water Research (IWR) for a project entitled "Restoring Great Lakes Basin Waters Through the Use of Conservation Credits and an Integrated Water Balance Analysis System." The IWR is responsible for coordinating and collaborating multidisciplinary teams from various organizations including the World Resources Institute, Institute for Fisheries Research of the Michigan Department of Natural Resources, Public Sector Consultants of Lansing, US Geological Survey District Office, and MSU Departments of Agricultural Economics, Biosystems and Agricultural Engineering; Geography, Civil and Environmental Engineering; and the Community, Agriculture, Recreation and Resource Studies (CARRS).

The project will integrate three systems -- Water Conservation Credit, Water Balance Analysis, and the User Assistance Interface, into a single Water Conservation Credits Implementation package. Large water users, including municipalities, corporations, and irrigation users, who are considering major new withdrawals can benefit from the Water Conservation Credits Implementation package by being able to access information on the watershed in which they have an interest, and use this information in their management decisions to guide potential conservation transactions. Individually, the Water Conservation Credits System provides analyses to support the development of an innovative system of water conservation credits which will help policy makers manage water resources to meet the demands of water uses, conservation, and the improvement of ecological sustainability. The Water Balance Analysis System integrates three existing hydrological models that incorporate surface, groundwater, and stream aquatic ecosystem models. The User Assistance Interface System couples the hydrologic models with spatial data to allow a decision maker to create various scenarios for management of water resources in Michigan and the Great Lakes Basin. Combined, these systems can be used to assess the ecological vulnerability of watersheds, the impacts of wells on groundwater levels, river and ecosystems, the effectiveness of conservation practices and associated water conservation credits, and other issues. State agencies in the Great Lakes Basin who are responsible for the improvement of water resources and the health of the Greater Lakes Basin ecosystems can use the system package to support development and implementation of state and regional water management policies. Products will be designed as simple online tools by integrating information and models with appropriate interfaces to the water analysis system. The entire study process is guided with inputs from an Advisory Team composed of leaders from a wide set of interest areas.

Our web-based offerings continue to expand. A Nation-Wide Digital Watershed web site has been developed to allow individuals from across the United States locate themselves by using their address, watershed, or by regional areas established by the EPA. The illustration shows the software developed in the IWR that can be applied to a national situation. The data used in the system was acquired from EPA Basin data via the web. The site for Michigan allows users to zero-in on the eight-digit watersheds and then down to the 12-digit watershed system known as "Know Your Watershed." A special web site was prepared for the Kalamazoo Watershed project to assist them in prioritizing and developing a watershed management strategy. A substantial effort has been completed using all the digital orthoquads (DOQQ) available across Michigan. These have been acquired and seamlessly integrated with quality control and compression algorithms. This information now serves as a backdrop on our "Know Your Watershed" web site. The DOQQ integrated data set is also used as a backdrop for soils information on IWRs new EZMapper web site. This site was specifically designed to aid with Comprehensive Nutrient Management Plan development for agricultural farms throughout the state. The system allows downloading of software to outline fields and utilize the available data. Recently, automatic extraction procedures were added to Digital Watershed to incorporate DOQQ's imagery on the fly across the U.S. from Microsoft Terra Server.

IWR, Purdue University, and EPA Region 5 organized a workshop that examined web-based tools for land use and watershed planning. The Mapper is now under way to serve-up these tools across all states within Region 5, along with obtaining the same data that would be common for each state.

The web-available Mapping is used extensively in IWRs Virtual Watershed Management courses. This past year we offered all four 3-credit modules of Watershed Management each semester in the series for Certification. There are now over 200 students registered per year in these courses.

This past year much effort was put into “The Great Lakes Natural Resource Gateway: Michigan State University and the National Park Service Great Lakes I&M Network.” The scope of work for this project follows: The National Park Service’s (NPS) Great Lakes Inventory and Monitoring Network (GLKN) is responsible for implementing a long-term ecological monitoring program for nine National Park Service (NPS) units in four states around the western Great Lakes. The GLKN has funding to begin planning the monitoring program as part of a nationwide effort by the NPS to phase in 32 similar networks. During the planning stage GLKN must locate, assess, summarize, and make readily available critical natural resource information for the nine parks. This includes information originating inside and adjacent to parks collected by the NPS and many other federal and state agencies and non-governmental organizations (NGOs). At the onset, GLKN needs to have ready access to ecologically important inventories and monitoring efforts that put the parks and their natural resources into context. For example, regional and localized weather patterns, lake levels, stream flow, point and non-point sources of air and water pollution, human development and land use patterns are all critical perspectives that must be assimilated into the planning process. Many agencies, NGOs, and Universities have tabular and spatial data that are of high value to GLKN for initial planning and for future reference during the monitoring phase. It is essential that the information gathered, cataloged, and synthesized be made readily available for review and comment by the parks and science advisors who are located across the Great Lakes region and the nation.

The Great Lakes Network has selected Michigan State University (MSU), Institute of Water Research, as a partner through the Great Lakes - Northern Forests Cooperative Ecosystems Studies Unit (CESU), to provide a wide range of support in collecting, synthesizing, and making available information for planning and implementing a long-term monitoring program.

Objectives of the Project

GLKN needs to make critical natural resource information readily accessible to the nine parks and their partners. This includes acquiring regionally significant datasets on climate, water and air resources, human population growth and land use. These important datasets need to be analyzed and summarized to reveal significant trends and concerns relevant to the nine park units. The Network and MSU will work cooperatively to do the following:

- Design and build an interactive web site that provides GLKN parks and partners easy access to a wide variety of natural resource information. We envision a “one stop” clearinghouse of raw data and summary information. This would provide needed information during the planning process in the short term and as a mechanism for serving monitoring data in the long term. The web site will include links to other important web sites, access to newly developed information, electronic reports, relational databases, and

large spatial themes. Where possible, raw data will be made accessible through an application interface that allows the user to create queries and sort routines to download data. This may involve using ArcIMS and a database platform such as Oracle or SQL Server, but the setup cost and maintenance of such a system will be carefully considered first. Issues of data format, structure, archival and choice of coordinate systems for spatial data will also be addressed.

- Seek out and acquire access to regionally significant data and then examine for trends and significant events, evaluate gaps, and make recommendations on what the nine parks should monitor in the future. Significant data, summary tables and graphs, and technical reports on this effort will be made available on the web site.
- Develop a long term plan for expanding the proposed web-based information system and determine who conducts maintenance and upkeep. This plan will explore various hosts and means of serving data and weigh the costs and benefits. Ideally, GLKN will be the sole host and maintainer of the system; however, cost and expertise will be considered. MSU will work closely with the Network to determine the most cost efficient method of providing easy and reliable access to information by the parks and partners.
- Create FGDC-compliant metadata for all databases and GIS products created and served under this agreement. Metadata will include documentation of stewardship and how products were developed.
- Participate in and help facilitate three workshops aimed at building the scientific credibility of GLKN's I&M program and developing lists of indicators to monitor in the Great Lakes parks.

Our work with the Michigan Department of Environmental Quality (DEQ) continues at a high level. With funding, between \$700,000 and \$1M dollars per year, it is largely the result of the Institutes' responsibilities being recognized statewide. This cooperation has led to a major role coordinated by the USGS Michigan Water Science Center and IWR; details follow. The U.S. Geological Survey (USGS) and Michigan State University (MSU) are leading a cooperative effort to assist Michigan Department of Environmental Quality (MDEQ) in meeting the requirements of Section 32802 of Public Act 148. Interim products, task-specific work plans, appropriate review and comment periods, and quarterly project meetings, or at more frequent intervals, as requested by MDEQ or necessitated by project accomplishments.

The project activities are organized according to the parts of Section 32802. All project activities described below will be part of a team effort including MDEQ, USGS, and MSU. All activities, however, have an identified lead or co-lead role. Product completion dates, as well as timeframes for completing sub-activities necessary to meet completion dates, are identified. Also included is \$1,150,000. MDEQ funds of \$900,000 will be split equally between USGS and MSU. USGS Cooperative Water Program funds of \$250,000 will be added to the USGS component of the project.

- (a) Location and water yielding capabilities of aquifers in the state
- (b) Aquifer recharge rates in the state
- (c) Static water levels of groundwater in the state
- (d) Base flow of rivers and streams in the state
- (e) Conflict areas in the state

- (f) Surface waters, including designated trout lakes and streams, and groundwater dependent natural resources, that are identified on the natural features inventory
- (g) The location and pumping capacity of all of the following: (i) industrial or processing facilities registered under section 32705 that withdraw groundwater, (ii) irrigation facilities registered under section 32705 that withdraw groundwater, (iii) public water supply systems that have the capacity to withdraw over 100,000 gallons of groundwater per day average in any consecutive 30-day period
- (h) Aggregate agricultural water use and consumptive use, by township

Our strategic plan for the Michigan Institute of Water Research (IWR) over the next five years has been developed and submitted to the Director of the Michigan Agricultural Experiment Station, the Dean of the College of Agriculture and Natural Resources at Michigan State University (CANR-MSU), and subsequently to the Office of the Vice President for Research and Development. The strategic plan outlines a number of key strengthening components for the MI IWR. (1) The affiliate positions within the Institute. These positions might be 25% time in the IWR and 75% in a discipline department. A group of affiliates would greatly strengthen the discourse relative to problems and techniques for solving them as well as the information dissemination. Additionally, adjunct faculty are generally somewhat less involved but enhanced mutual awareness of our programs would greatly enrich the pool of expertise of water scientists from which we could draw upon in order to more effectively address issues of concern within IWR. (2) Enhanced funding for the IWR: New Fiscal Support: Facilitating a competitive grants program in the water arena has been proposed. Preliminary discussions relative to the plan are leading to the strong possibility of adjunct and joint affiliate positions, but any new funding is on hold in light of the State's budget difficulties.

Related Research

We continue to obtain synergistic impacts by closely aligning our efforts with support from such organizations as the Corps of Engineers, USDA, US Forest Service and numerous other agencies and NGO's. This past year we received a grant from the Corps of Engineers for \$60,000 which involves estimating sediment delivery from each of the eight-digit watersheds within the entire U.S. side of the Great Lakes Basin. This database is not only of value to the Corps in prioritizing their efforts but also provides us with a broad set of additional information that we can use in other programs, and for assisting with the prioritization of high risk areas for erosion throughout the region. USDA funds involve a coordinating effort of outreach and research among all states within the EPA Region V. IWR personnel are partially funded through this regional project which coordinates and facilitates the communication of research methodologies, approaches, and results from our research and aides with region-wide outreach programming.

Training Potential

New graduates and graduate training continue to be a high priority of IWR. Unfortunately, graduate stipends have increased to the extent that a 1/2 time graduate student with fringe benefits, requires from \$30,000-\$40,000 (per year). We will make every effort to continue incorporating graduate students but with the high cost, it is increasingly difficult to employ more than a few students at any given time. As part of our partnership philosophy, we have jointly supported numerous graduate students with other departments and units on campus.